IP use of VDL Mode 2

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Overview

- INTRODUCTION
- IP based Applications
- IP Air-Ground Networks
- IP use of VDL Mode 2
- SITA IP/VDL prototype
- CONCLUSION

Introduction

- **Cockpit data link is still using the ACARS protocol defined in the 1970's based on telex formats. The industry has introduced new Communication Protocols :**
  - **The Aeronautical Telecommunications Network protocol has been defined in an ICAO standard based on a ISO standard protocol called Connection Less Network Protocol (CLNP), which has not been used in any other industry.**
  - **The Internet Protocol (IP) has become the generic protocol used for all data communications, including for mobile terminals and it is being implemented in airborne systems.**
- **IP is being implemented in the cockpit for use by Electronic Flight Bags which are proving to be the platform for future bit-oriented AOC applications.**
  - **Use of IP as a viable Air-Ground datalink is currently defined in AEEC 763 for Gatelink while Aircraft are on the Ground.**
  - **Aircraft while Airborne can use IP over Inmarsat Switft64 (upgrade to the current Aero-H)**
  - **IP can also be implemented over VDLM2 for EFB use, as more and more aircraft are equipped and use VDLM2 service**

IP based Applications

- **Application need for Air-Ground communications is there**
  - **Need to identify which application can use which media**

Flight Deck

Graphical Weather

Cockpit E-mail

Database Update

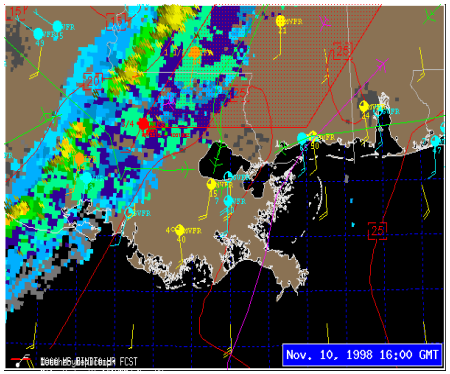
Charts and Maps

Electronic Manuals

Performance Calc.

- **Weight and balance**
- **Take-Off Data**
- **Airline Manuals**

Electronic Logbook



Maintenance

Virtual QAR (FOQA Data)

Electronic Logbook

Engine Monitoring

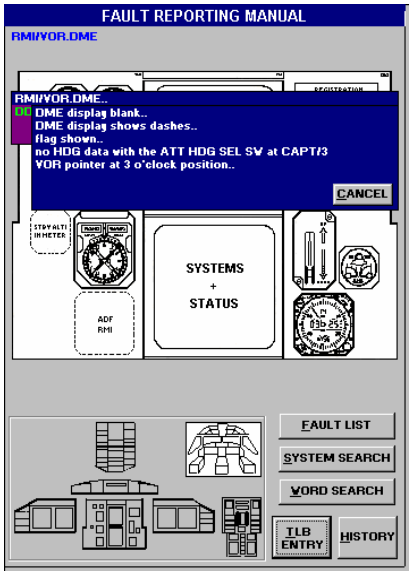
Graphical Fault Reporting

Maintenance Manuals

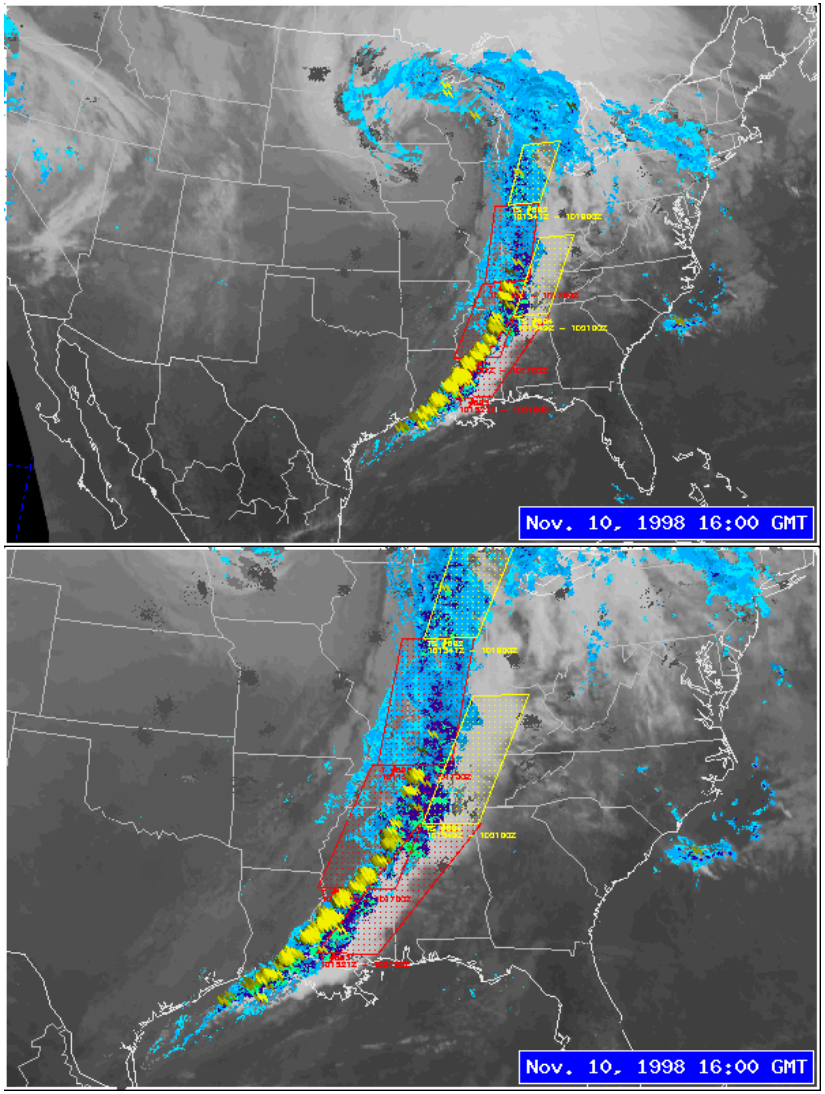
615 Data Load

Equipment Lists

- **Parts Ordering**

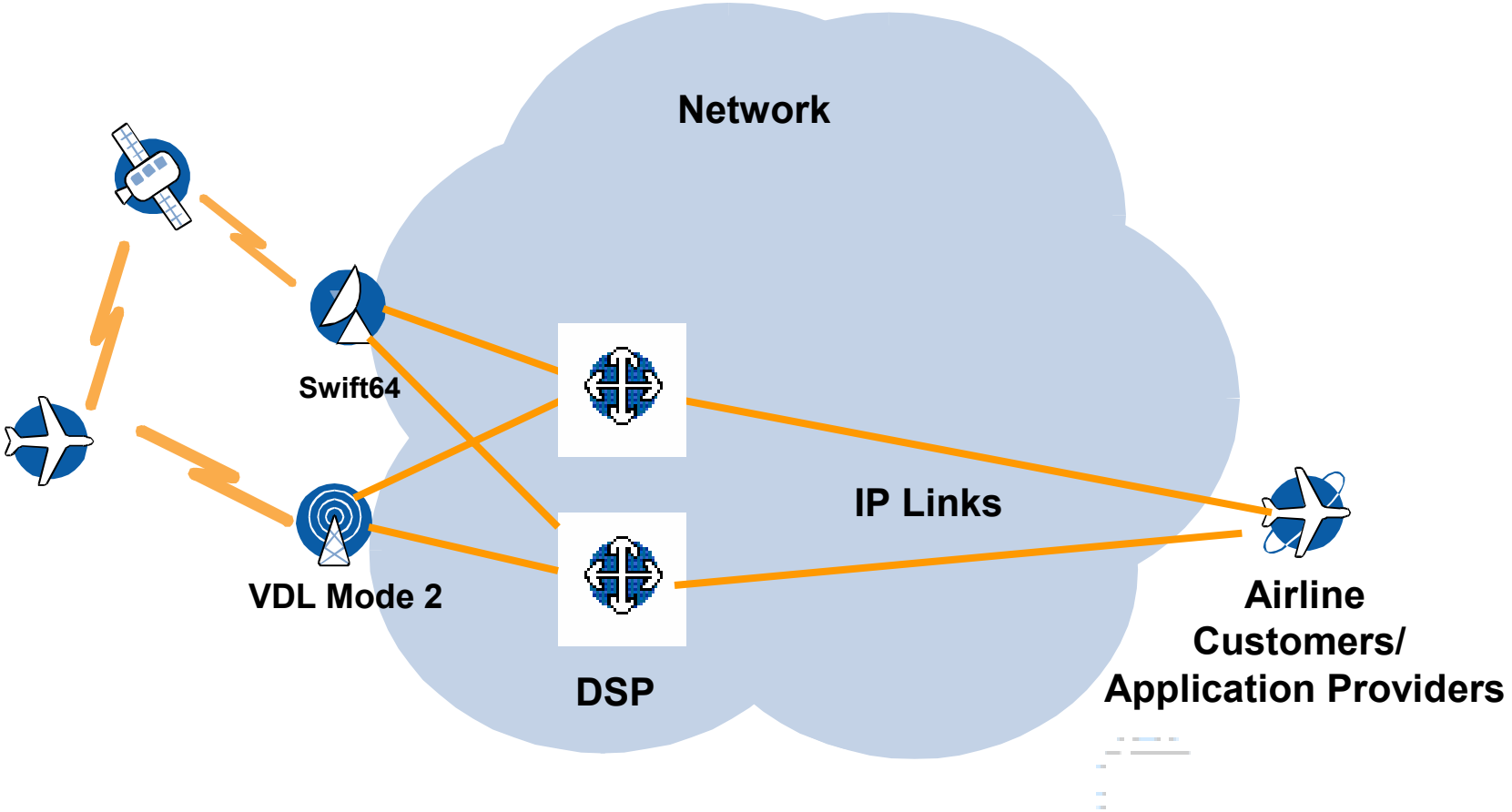


Example – Enroute Graphical Weather

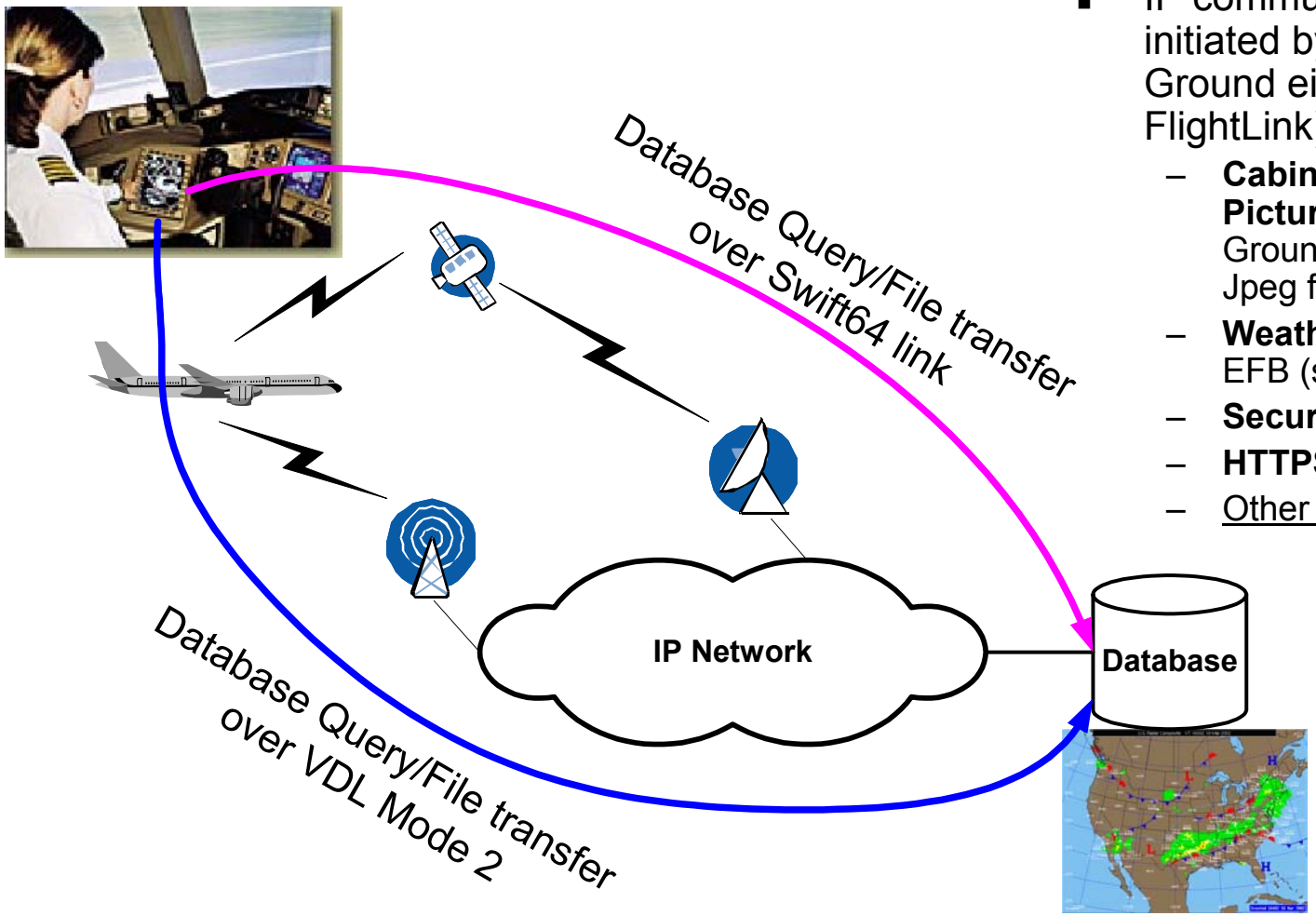


- Both the Airline Operations Center and the Pilot Can View the Same Data
- Thus an Informed Pilot Can Better Negotiate Future Decisions
- The Pilot Has Zoom Capability Which Enables Greater Precision in Creating an Efficient Diversion If Necessary
- One good candidate for IP/VDL as well as Swift64
- Certification and HMI for pilot use will need to be carefully assessed
  - Don't want to distract the pilot from primary tasks

IP based Air-Ground Networks



IP based Air-Ground Networks (con't)



- IP communications can be initiated by the **EFB** to the Ground either via Swift64 (Aircom FlightLink) and VDLM2
  - **Cabin Video Surveillance Pictures** can be sent to the Ground (Snapshot) – e.g.; picture Jpeg format
  - **Weather Maps** uploaded to the EFB (secure file transfer)
  - **Secure E-mail**
  - **HTTPS**
  - Other Applications to be defined

IP use of VDL Mode 2

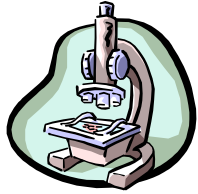
Objectives

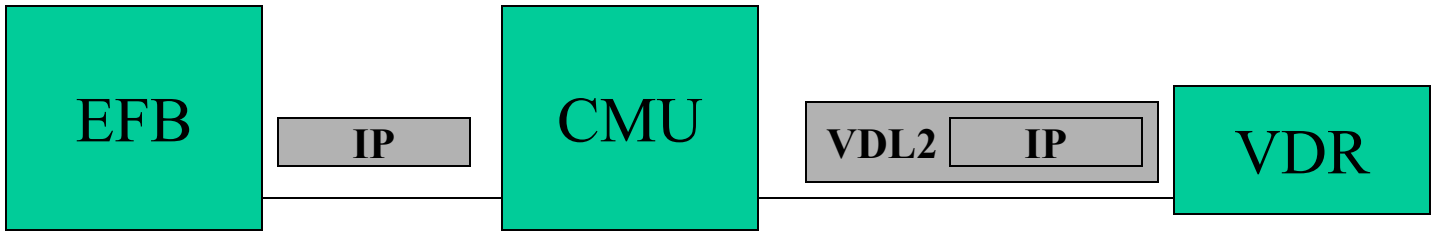
- Enable bit-oriented cockpit applications
- Complement and Extend current ACARS

Minimum Aircraft requirement

- AOA-only A/C should be able to be upgraded via SW change only to benefit from IP/VDL
- Ethernet port or 429 CMU interface
- A System hosting the Application (e.g., EFB) and the TCP/IP stack outside the CMU
- Evolutive Architecture towards 664/763 standards
- Security needs to be addressed but no overkill
- Minimal impact on CMU software – the CMU should act as a bridge only

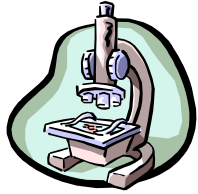
IP use VDL Mode 2 (con't)

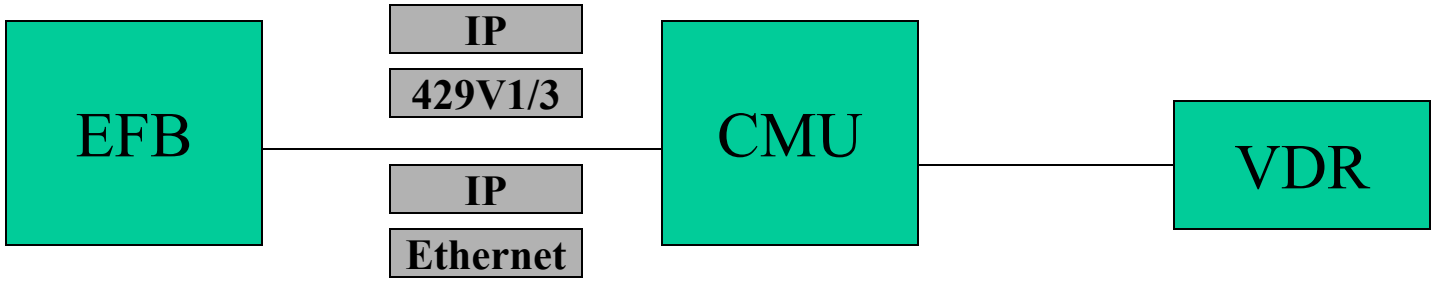




- What protocol layer to encapsulate IP datagrams ?
  - Over AVLC ?
    - Same level as AOA implementation
    - Re-use of AOA mechanism such as IPI/EPI
  - Over 8208 ?
    - 8208 already developed by a majority of Vendors for ATN
    - Standard IETF RFC supporting PPP or IP over X.25
    - Packetization in place to segment IP frames
  - Over CLNP/8208 ?
    - Standard IETF RFC supporting generic encapsulation model (GRE is described in RFC 3147)
    - Overhead may be detrimental to the application

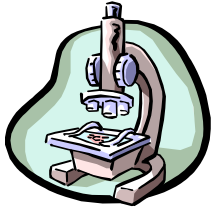
IP use VDL Mode 2 (con't)

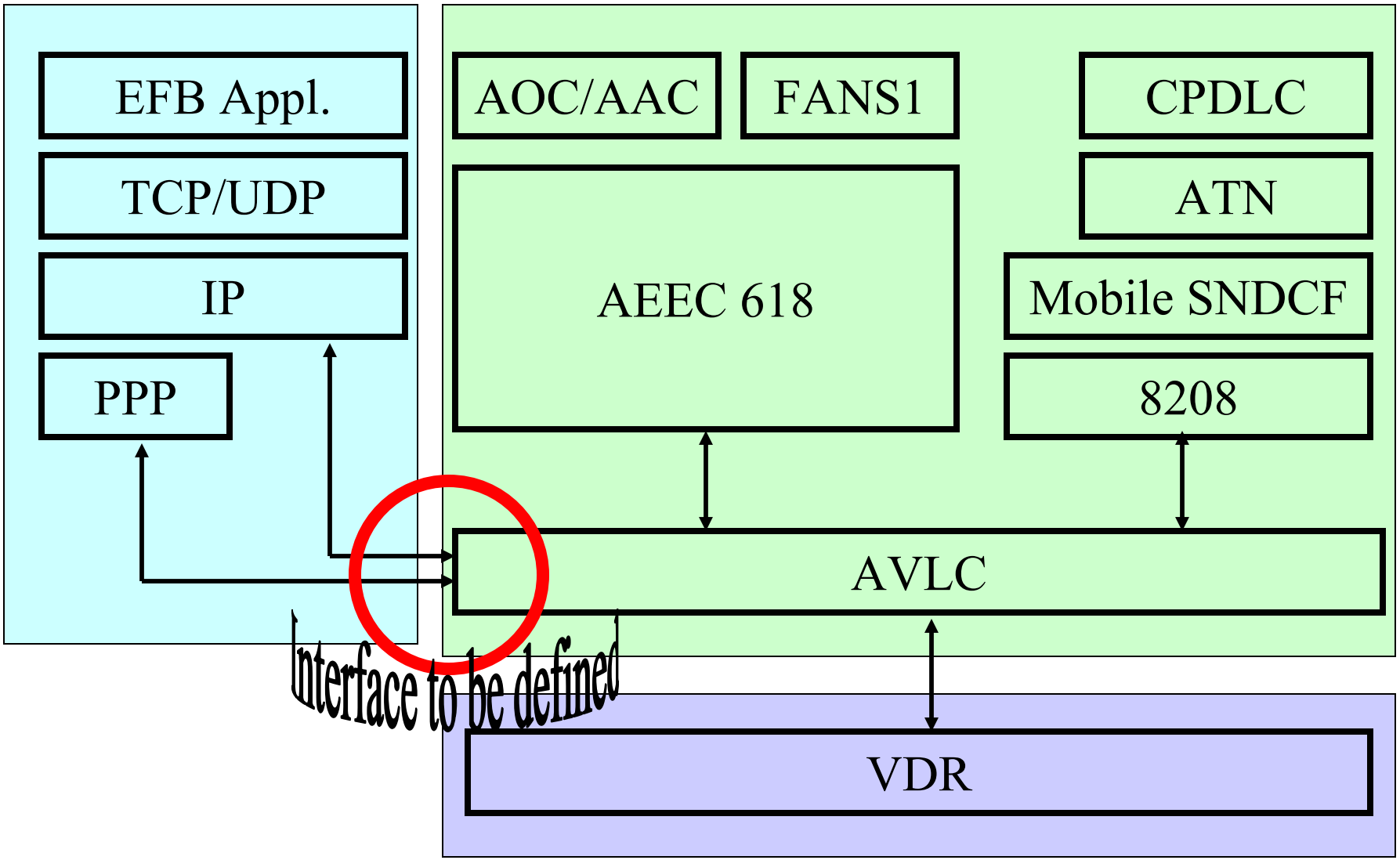




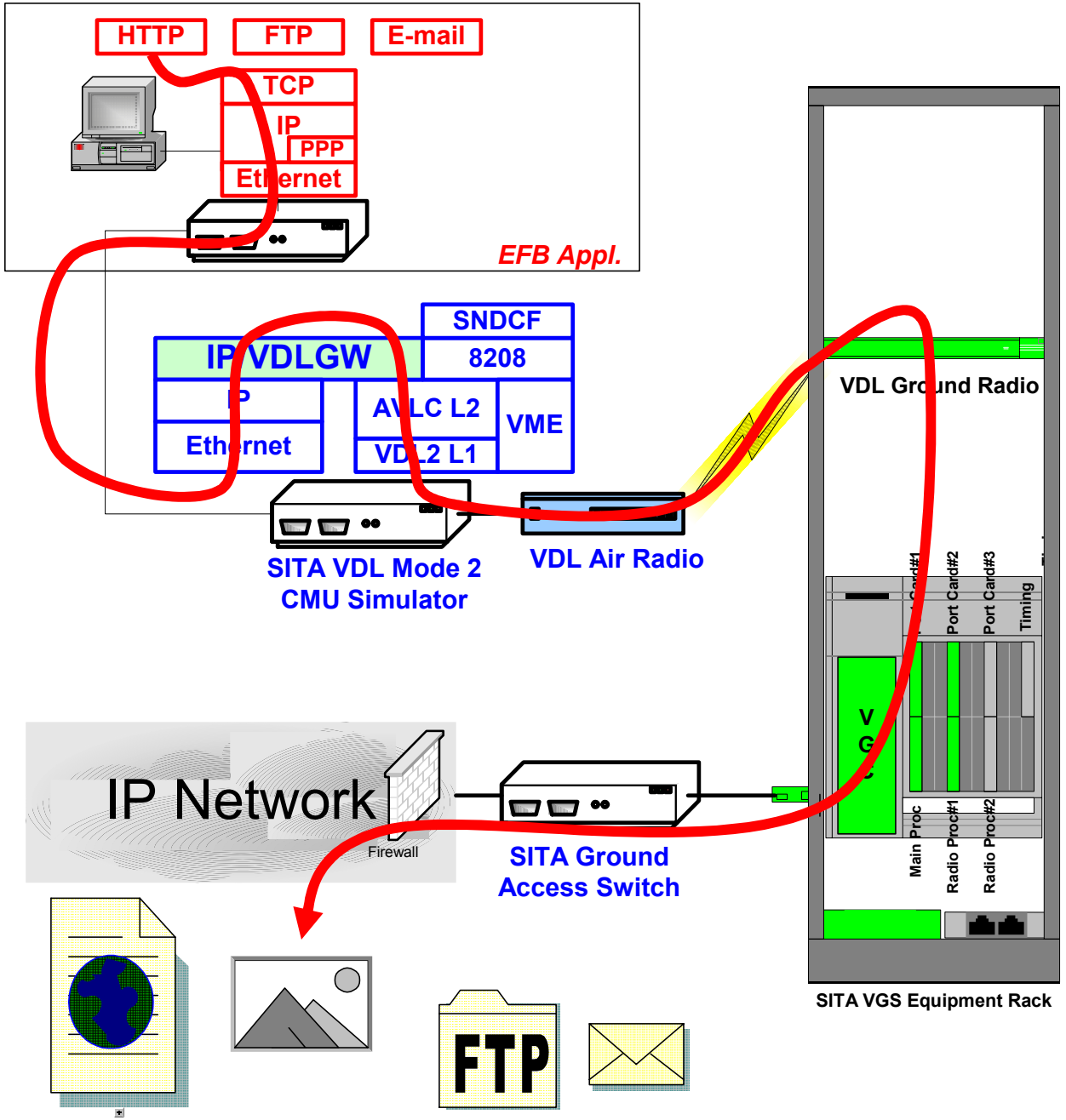
- What Interface between the CMU and the EFB ?
  - EFB has already an ACARS definition (H1 label) using the 429 and 619 definition
  - 429 V1 ?
    - May not be efficient for IP transfer
  - 429 V3 ?
    - Version 3 framing is almost identical to an Ethernet frame
    - Very efficient for transferring data
  - Ethernet ?
    - This would be the most standard way of transporting IP (or PPP) frames
    - Need the CMU to support Ethernet and some form of Ethernet/429 gateway

IP over VDL Mode 2 (con't)





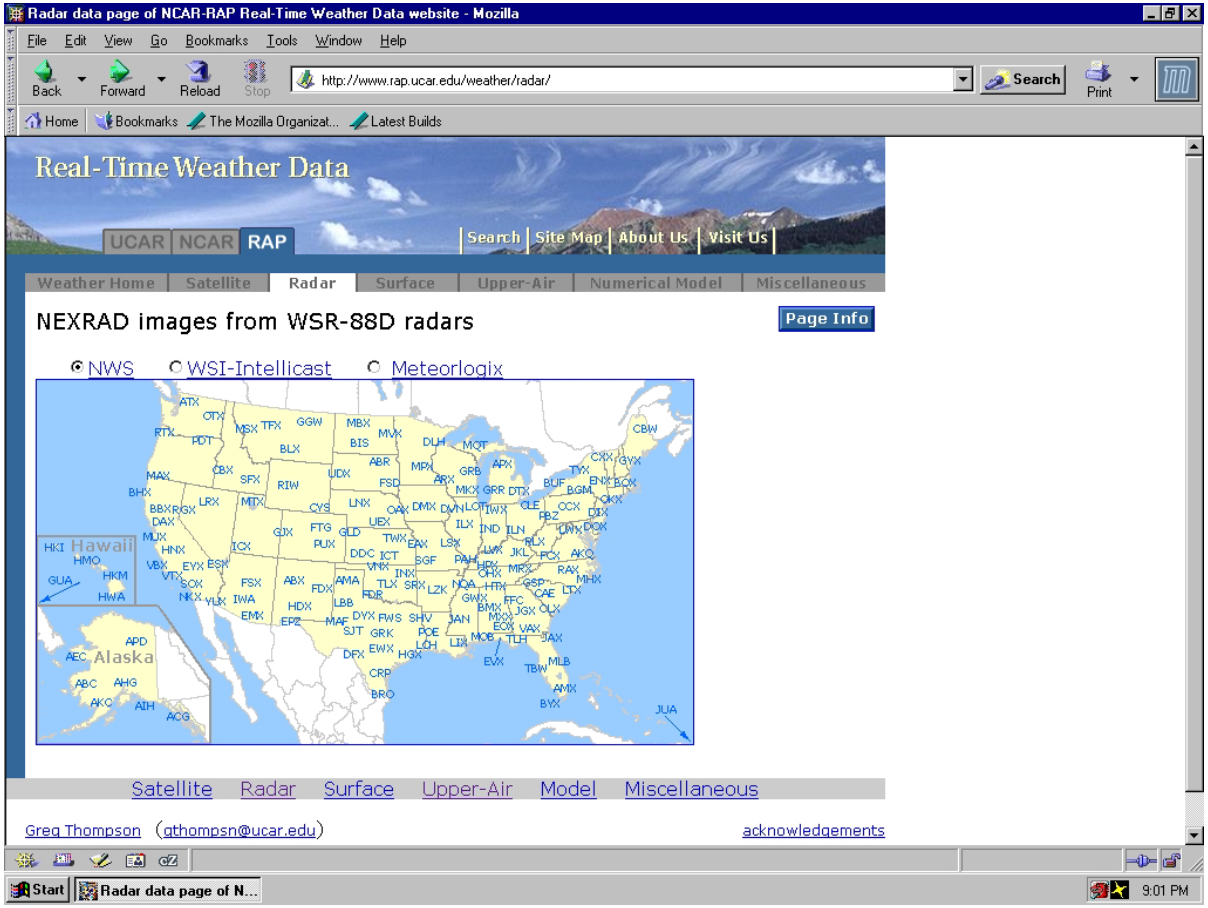
SITA Lab Testing of IPoV



SITA IP/VDL Lab Test Results

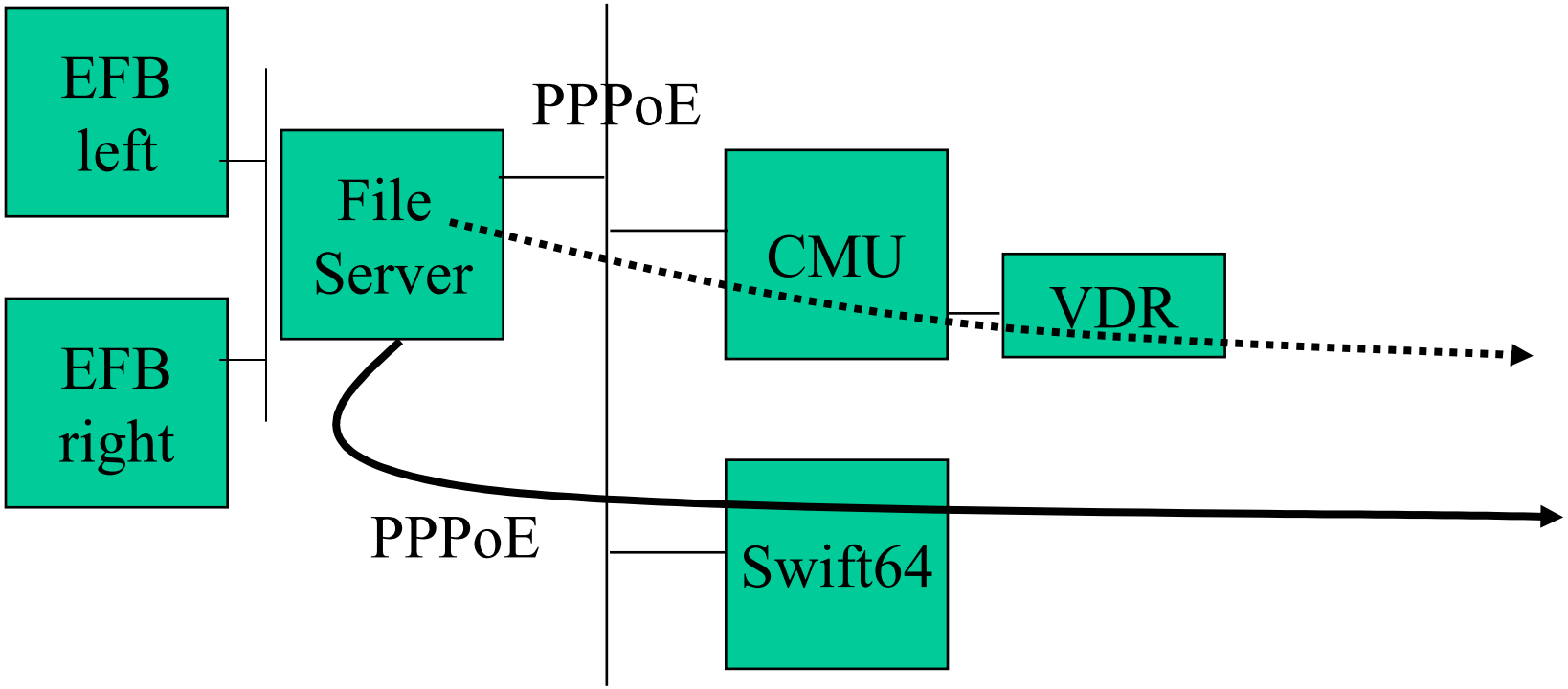
- SITA has built a full end-to-end IP/VDLM2 environment
- Target Applications are COTS Web Browsing, E-mail and FTP/TFTP
  - SITA tested all three applications without any optimization in place (test the worth case)
- SITA develop an IP/VDL Gateway in its CMU Simulator that has the full VDL Mode 2 stack
  - 4 weeks rapid prototyping using IP/8208 at this point
  - Plan to integrate the PPP stack
  - Supports VDL Mode 2 handoffs and Aircraft mobility

SITA IP/VDL Lab Test Results (con't)



- **Full Web page: 80 seconds to load without any optimization (worth case test)**
- **Down to 55 secs with VDL mode 2 parameter tuning (RF burst, WS)**
- **Can go to 30 secs with TCP/IP parameter tuning**

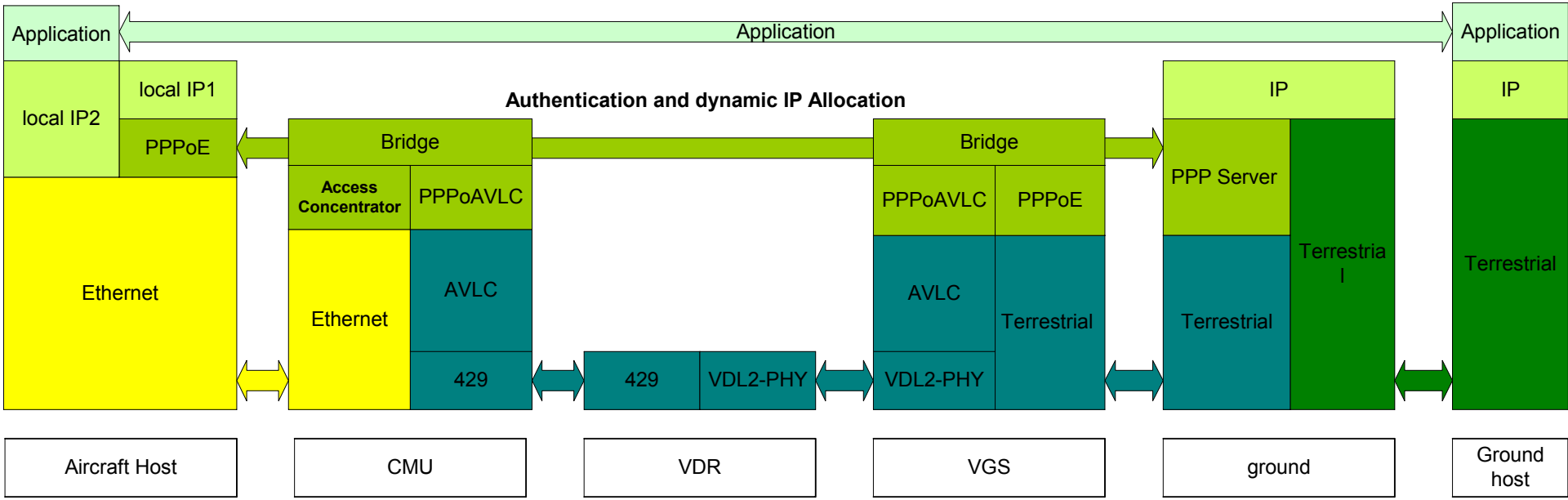
Aircraft Architecture – PPPoE evaluation



PPP/PPPoE is already being used with the Swift64 Unit, and VDL Mode 2 can accommodate the same architecture

End-to-End Architecture – PPPoE evaluation

IP over VDL Mode2 (PPPoAVLC) - CMU based Concentrator



- The CMU has an Ethernet port available (or 429)
- The Application is hosted on a separate on-board unit (EFB) connected to the same LAN
- as the CMU
- The EFB (or File Server) is running PPPoE Client
- The CMU implements the Access Concentrator and the bridge function
- This architecture could include a Router or not depending on the on-board architecture
- Similar to the Inmarsat Swift64 architecture

Easy Integration with current Airline IT

- Airlines migrating to IP today understand the process of connecting a Host to a DSP IP Network
  - Exchange ACARS 620 messages via MQseries or MATIP
- This existing IP access can be re-used to reach IP/VDL (or Swift64) capable Aircraft
  - Cost saving from investment made in the IP WAN Connection
  - An Airline Host doing ACARS 620 over IP today will be able to use IP directly to its Aircraft.
  - The Aircraft becomes an extension of the Airline IP Network
- Security to be addressed as an IT activity
  - Aircraft will always initiate the IP communications
  - Strong authentication can be used (EAP-TLS a la 763)
  - Application Encryption can be used (sFTP, HTTPs, Secure E-mail)
  - Security = Overhead

Integration with current Airline IT (con't)

- Mobility Management
  - Completely handled by the DSP (a la ACARS) and transparent to the Airline (no need of IDRP-like mobility management)
    - Layer 2 Mobility
- IP address management and control
- Domain Name Service (DNS) management
- SMTP Email relay available for Cockpit e-mail
- On-board End-Systems (e.g., EFB) may be reachable by a DNS name.
  - e.g. : EFB.<tail>.<airline>.<media>.aircom.aero

Conclusion

- IP is seen as THE candidate for bit-oriented Cockpit Applications – and EFB in particular
  - AOC bit-oriented applications hosted in EFB should be able to use IP
    - SITA demonstrated a prototype working with Aircraft moving from one VDL Station to an other, keeping the IP connection alive
  - Use of COTS software is one key element in moving towards IP
    - Cost benefit
    - Rapid introduction of new AOC Airline application
    - Certification challenge; however very achievable as demonstrated by the introduction of EFB in the Aircraft
  - As we have today VHF ACARS and SATCOM ACARS in place, the next obvious step should be VHF IP and SATCOM IP.

Comments & Questions